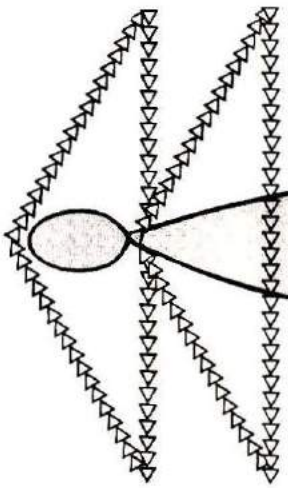

The Delta-Loop Antenna Rides Again

BY HARRY LEEMING, G3LLL

After I moved to a new location in November, 1976, my thoughts turned to antennas. At that time the only band offering a chance of trans-atlantic QSOs was 20 meters. A beam was considered essential if contacts were to be at all pleasurable.

After much thought and consideration I decided to try a delta-loop beam, and after some trial and error this resulted in the inverted-V, two-element delta loop described in *Ham Radio Horizons* for June, 1978.

The delta loop is really an out-of-shape quad and seems to retain the quad's qualities. Like the quad, it is famed for good results when mounted at modest heights, and this is usually attributed to a low angle of radiation. Perhaps this is true, but vhf tests do not seem particularly convincing. There may be other reasons. Perhaps the loop construction results in a "contained field" with less signal lost in nearby objects. Loops are certainly quiet on receive, and it would seem sensible that an antenna which picks up less interference from local electrical wiring in the receive mode also wastes less rf on transmit by not pumping it into the same wiring. Certainly loop antennas do seem to produce fewer RFI problems and more DX, and, after all, that is what most of us want. Theoretical arguments aside, to me even a one-element delta loop seems to be at least an S-unit ahead of the most carefully trimmed and oriented multi-band dipole.

To return to the story — after having used the 20-meter, two-element delta loop for a few months, the sun broke out in spots, and 15 meters opened. I temporarily interlaced a 15-meter driven element inside the 20-meter-element. This made a very satisfactory antenna, but, like Oliver Twist, I still wanted more. Next, a reflector was put in place. This gave me some gain toward the U.S. By this time winter was approaching and antenna activity for the next few months was confined to putting things back every time they blew down!

The new loop

With the advent of spring 1978, the delta loop was long overdue for rebuilding, and to ensure future reliability I decided to completely dismantle it and start again. Previous rough measurements had seemed to indicate that the length of wire required was somewhat more than that normally used for quad loops. Therefore, I decided to make more accurate measurements so as to help anyone who wished to duplicate the antenna. The previous construction was of No. 22 AWG (0.6-mm) wire for the loops, but this could not withstand storms. I selected copper/nylon braid for the new antenna because of its strength. This brought a bonus in that it proved to have much less tendency to "whistle" in strong winds.

I then decided to make the antenna cover the three main long-distance bands, and first of all the driven elements were installed and experimentally altered in length until they were resonant in the center of the three bands. The required length of copper/nylon braid varied, depending upon the shape of the antenna, but the eventual shapes and lengths that proved satisfactory are indicated in **Fig. 1**. No measurements of impedance were made, but various handbooks would lead one to expect that the impedance of the driven element operated on its own would be somewhere in the region of 100-150 ohms. This seems to be the case, as feeding the driven element

directly with 75-ohm coaxial cable results in an SWR of between 1.5 and 2 to 1.

At the time that I was rebuilding the antenna, a friend, G4GCT, was experimenting with various designs of balun transformer, and measurements of their loss were made. Some samples showed a slight loss, and this loss increased when they were encapsulated. For comparison purposes an expensive commercial balun was obtained and was found to be surprisingly inferior to most of the home-brewed samples, giving a loss of almost 1 dB. This may not seem like much, but losses add up, and even 1 dB brings the output of a 200-watt transmitter down by 30 watts or so. Give the same inattention to two other lossy points and you are down to half power.

Being in the hi-fi trade, I have long since proven the extreme efficiency of ferrite cores in stopping rf from flowing on the surface of leads entering hi-fi amplifiers. A quick check with a dummy load fed with a length of coaxial cable wrapped round a ferrite core showed no loss of power or increase of SWR, and so, while good results had been obtained without a balun of any kind, I decided to install a ferrite-core, choke-type balun. The coaxial cable was disconnected from the antenna, wrapped six times round two 38-mm (1½-inch) stacked cores, and reconnected to the antenna. It works! Previously, I had been able to hear a distorted version of my voice in the headphones while transmitting on my FT-101. The balun cured this, so it obviously has stopped rf from coming down the outside of the coaxial feeder. It seems, therefore, that a couple of 50-cent cores will do all that a $20 balun will, except give a 1 dB loss!

Being eager to get back on the air, I used the antenna in its one-element form (firing east/west) for some weeks. Very good results were obtained, and I wondered how I could retain this feature, and yet have a good front-to-back ratio and gain toward the U.S. when I wanted it. A note in the Radio Society of Great Britain's booklet *Amateur Radio Techniques* referred to a solution advocated by W6AJZ. Why not bring the reflector adjustment into the shack? W6AJZ's method is shown in **Fig. 2**. A length of transmission line runs from the center of the reflector to the operating position. If this line is electrically an exact number of half wavelength long, it effectively brings the center of the reflector into the shack so that adjustments can be carried out in comfort.

A second 20-meter element was slung from the fm broadcast antenna which is mounted on top of the mast. It was positioned so that at the bottom it was around 3 meters (10 feet) from the driven element. One electrical wavelength (approximately 17 meters, or 58 feet, allowing for the velocity factor) of 300-ohm ribbon feeder was connected to this element at the center, the other end being brought down to the operating position. A one-turn loop was connected to the end of the 300-ohm feeder to allow checking with a grid-dip meter. The element proved to be resonant at 14.2 MHz. Short extra lengths of 300-ohm feeder were added until resonance fell to 13.8 MHz, and a 500-pF variable capacitor was then connected in place of the loop as shown in **Fig. 2**. This allowed the

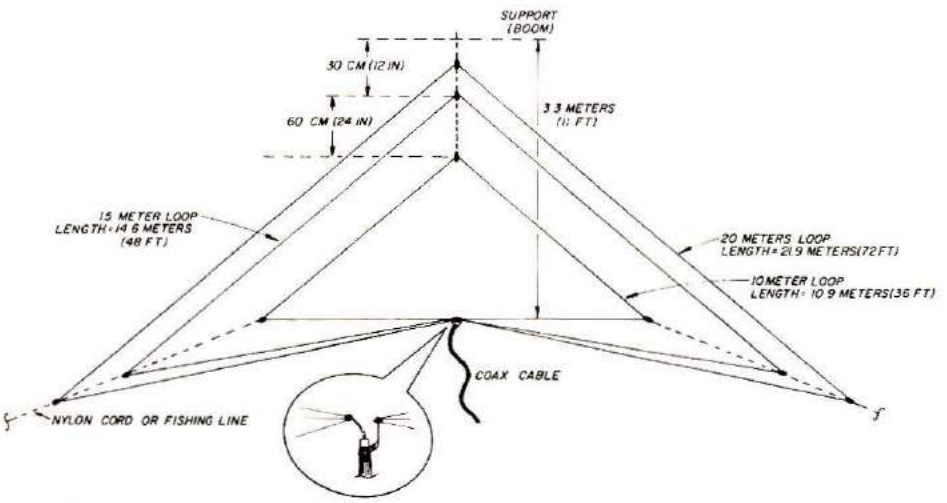
SUPPORT (BOOM)
30 CM (12 IN)
60 CM (24 IN)
3.3 METERS (11 FT)
15 METER LOOP LENGTH = 14.6 METERS (48 FT)
20 METERS LOOP LENGTH = 21.9 METERS (72 FT)
10 METER LOOP LENGTH = 10.9 METERS (36 FT)
COAX CABLE
NYLON CORD OR FISHING LINE

Fig. 1. Dimensions and mounting details for the driven elements of the delta-loop antenna. Loops of the same size can be used for reflector or detector if fed with twin-lead transmission line as described in the text. Nylon cord or fishing line is used to support the tops of the loops and to pull the bottom corners out to position. Lengths given for the loops are total length of wire around the loop.

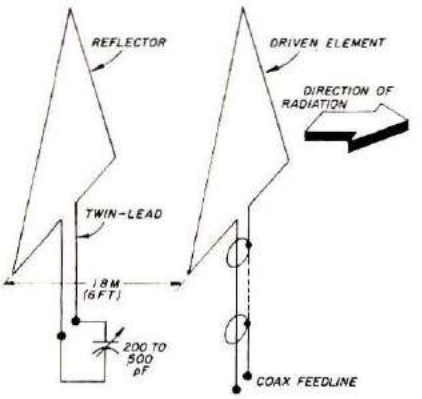

Fig. 2. The basic configuration of a two-element delta-loop beam. The tuning capacitor adjusts the reflector to resonance for best gain and directivity of the beam. It can be located in the shack at the end of twin-lead feeder which is a multiple of a half-wavelength, as discussed in the text.

resonant frequency to be altered.

This was it — would it work? Well, yes and no! A gain toward the U.S. of about one element. The SWR was found to be almost completely unaffected by the tuning of the reflector, and so my conclusion was that the delta loops were spacings of around 2.4 to 3.6 meters (8 to 12 feet) and it is not clear just why such close spacing is needed for the best results with my delta loop.

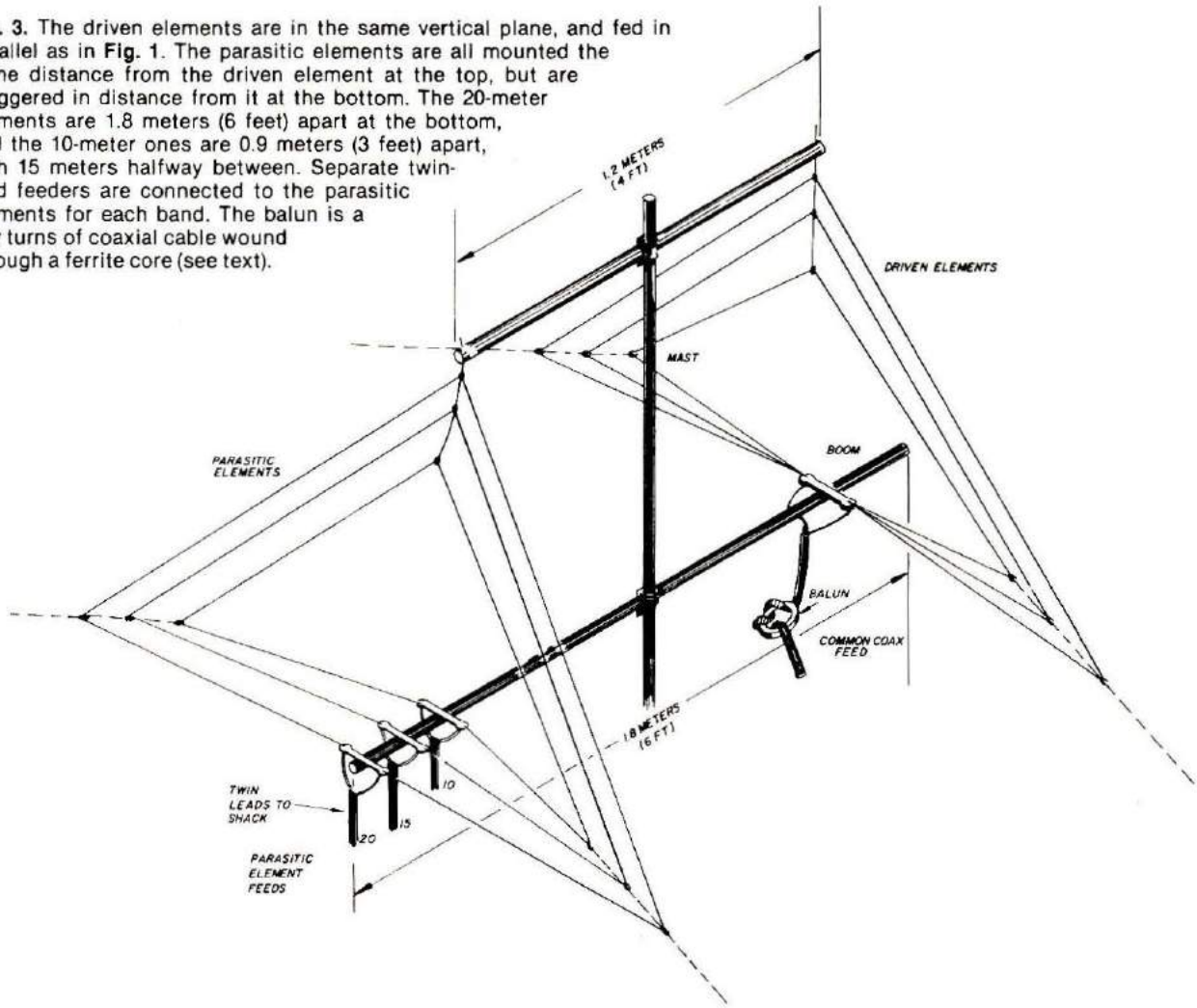

Fig. 3. The driven elements are in the same vertical plane, and fed in parallel as in **Fig. 1**. The parasitic elements are all mounted the same distance from the driven element at the top, but are staggered in distance from it at the bottom. The 20-meter elements are 1.8 meters (6 feet) apart at the bottom, and the 10-meter ones are 0.9 meters (3 feet) apart, with 15 meters halfway between. Separate twin-lead feeders are connected to the parasitic elements for each band. The balun is a few turns of coaxial cable wound through a ferrite core (see text).

S-unit (over the delta loop on its own) occurred when the capacitor was set at anything above about 50 pF or so. The front-to-back ratio was very poor, adjustment of the capacitor was very broad, and the tuning very flat. Attempts to tune the reflector to act as a director were disappointing and produced no gain or front-to-back ratio at all.

At this point I decided to recheck the standing wave ratio, because adjustment of a parasitic element should normally have quite an effect on the impedance of the driven element. The SWR was found to be almost completely unaffected by the tuning of the reflector, and so my conclusion was that the delta loops were too widely spaced. This was indeed the case, and, upon reducing the spacing to 1.8 meters (6 feet), things really started working. The front-to-back ratio increased dramatically. By altering the length of the feeder cable slightly and tuning the variable capacitor, I was able to fire the beam east or west, although with somewhat less gain when the reflector was tuned as a director. The SWR was also quite sensitive to the tuning and could be brought down to around 1 to 1.

Normal quads and delta loops for 20 meters use spacings of around 2.4 to 3.6 meters (8 to 12 feet) and it is not clear just why such close spacing is needed for the best results with my delta loop.

Perhaps the following points are worth thinking about, however:

1. Most measurements of quads and delta loops are made on vhf scale models which are mounted several wavelengths in the clear; the presence of the roof could be affecting results.
2. The thickness-to-length ratio of the vhf antenna elements is likely to be very much different from that of a high-frequency antenna even if wire, rather than tubular elements, is used.

3. Having the tuning control in the shack enables instant reversals to be made, and hence the merits or faults of the antenna are more readily noticed. A spacing of 1.8 meters (6 feet) gave the best results, so whatever the textbooks say, and whatever the reason, this it remains!

Next, a 15-meter reflector was added and connected to the same 300-ohm feeder, which, on 15 meters, was 1½ wavelengths long. This was not a success, and while slight gain and front-to-back ratio resulted, the tuning was poor and indecisive. Also, 20-meter operation suffered. Hence, it was found necessary to use a separate 300-ohm feed for each band.

The final design

Ideally, the elements should be spaced at 0.9, 1.3, and 1.8 meters (3, 4, 5, and 6 feet) respectively, at the top as well as the bottom, but the arrangement shown in **Fig. 3** is mechanically convenient and works well. The feeder from the driven element can be any good quality 75- or 50-ohm twin or coaxial feeder. The feeder from the reflector should be open wire or TV-type ladder feeder, but 300-ohm ribbon works quite well unless you reside in a very damp climate. Be sure that the parasitic-elements feeder is kept well away from any metal objects, and, if possible, mount it on stand-off insulators. The electrical length of a half wavelength is approximately 5½, 7, and 11 meters (18, 24, and 36 feet) on the three bands, and open wire or ladder feeder should be cut to a multiple of this: for instance, 21.9 meters (72 feet), which equals 2 × 36, 3 × 24, and 4 × 18 feet. This is a suitable length for all bands. 300-ohm ribbon feeder has a velocity factor of around 0.8, and so a length of about 17.6 meters (58 feet) is suitable. When you have decided on the length of parasitic feeder, add about 1.2 meters (4 feet) to the 20-meter feeder, 0.9 meter (3-feet) to the 15-meter feeder, and 0.6 meter (2 feet) to the 10-meter feeder, so as to bring the element and feeder resonant as a reflector when the tuning capacitor is set at maximum.

Trying it out

First of all, test the driven element by measuring the SWR. If the elements have previously been trimmed and adjusted by a grid-dip meter the SWR should measure around 2 to 1.* The SWR will vary somewhat as you tune across the band, but if it goes above 3 to 1 and is much worse at one end of the band than the other, it will be necessary to adjust the length of the driven element to even out the response.

Once you have the driven elements working, install the parasitic elements. For convenience of construction, parasitic elements can be made the same size as the driven element, there being no need to adjust it exactly to frequency, as this will be done later from the operating position.

Next, bring all the feeders into the shack, and put one-turn loops on the end of the tuned feeders going to the three parasitic elements. Check, with a grid-dip meter, the resonant frequencies of the parasitic elements plus tuned feeders. There will be quite a number of resonant points, but main resonances should occur approximately 100-200 kHz below the lower end of each of the bands. If necessary, adjust the length of the open wire feeder until this occurs. Note that grid-dip meters are not usually accurately calibrated, and so the frequency should be checked against a frequency meter, or monitored on an accurately calibrated receiver.

Having done all this you are in business. Leave the coils in place and you have a three-band beam which will give good results in your favored direction. Disconnect the loops and wire in a variable capacitor of approximately 500 pF maximum, and the beam becomes reversible. If you measure the SWR you should find that maximum forward gain and front-to-back ratio, with the parasitic element acting as a reflector, occurs with the variable capacitor set very slightly toward the maximum capacitance side from that which gives minimum SWR. Maximum forward gain in the opposite direction occurs with the capacitor near minimum, and in my case results in an SWR of about 1.75 to 1.

Front-to-back ratio is about 3 or 4 S-units on local ground-wave stations, and on stations several thousand miles away. The gain under these conditions is 1½ to 2 S-units when operating a director. Directivity on stations less than a thousand miles away varies greatly with conditions, and can be as good as that indicated above or almost non-existent if reception

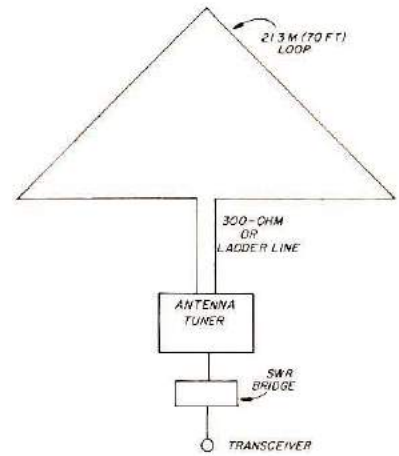

Fig. 4. A single loop can be made to work on three bands and fed with one feedline if you use a tuner and open wire line. It also works to some extent on 40 meters. It's a good substitute for a trap dipole.

*Connect a one-turn coil instead of the feeder to measure resonant frequency. You can only do this on the roof; you cannot grid-dip the driven element frequency at the end of the feeder.

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A simple version

During construction and testing of this antenna, the effect of using one 20-meter element as a multiband delta loop on 10, 15, and 20 meters was tried; it proved most effective. Directivity on 20 and 15 meters is the typical figure-eight pattern while as far as could be ascertained, good results on 10-meters short skip in all directions occurred. This arrangement is shown in **Fig. 4**, and can be highly recommended to anyone wanting good results for minimum effort.

Final notes

Signal fading makes it almost impossible to evaluate antennas over long paths by the usual method of making contact and asking for reports. If you doubt this, ask any station for comparative reports between "my old antenna" and "my new antenna," giving them two transmissions on the same antenna. Most stations will tell you that "the new antenna" is better — if you don't believe me, try it!

Resonant antennas should perform exactly the same whether receiving or transmitting, and should give the same gain in either mode. Comparative tests with antennas should be done in the receive mode, as this enables the test to be repeated and comparisons made with many stations. Tests carried out with only one or two stations can produce misleading results, as it is the average results that really matter and not what happens with a particular station under a particular set of conditions. Only after months of operations do the full merits of an antenna become clear — I can only say that I am delighted with the low-cost, reversible delta loop. If you hear me, give me a shout. **HRH**